

# Nourishment of the Global Oceans from Deposition of Atmospheric Dust Aerosol

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The story begins in 2016 with a comprehensive IDS proposal to study “Aeolian fertilization of marine ecosystems” in a carbon budget framework.

DECLINED by NASA

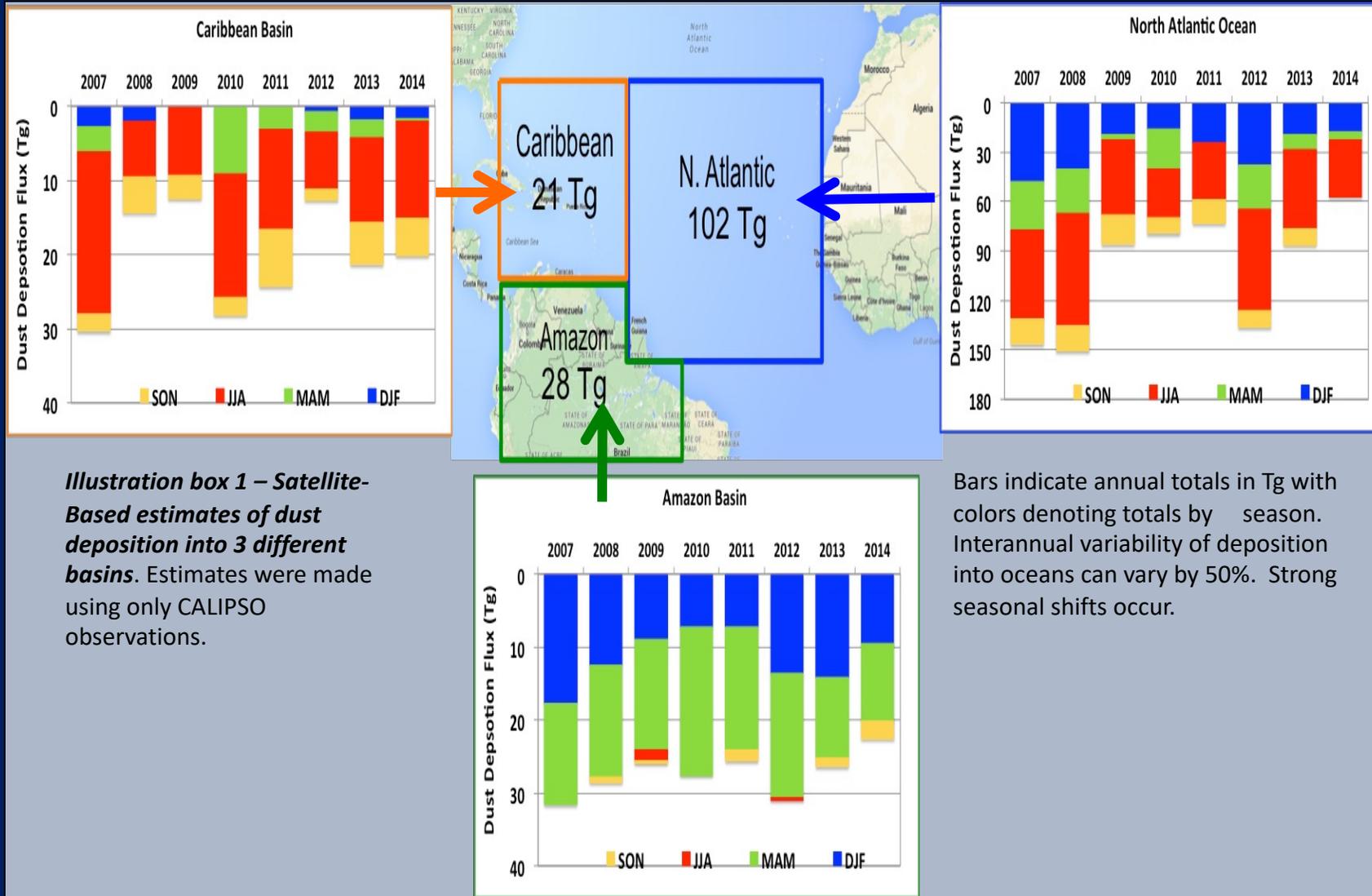
The story continues in 2017 with a pared down TASNPP proposal to “Understand airborne fertilization of oceanic ecosystems”.

SELECTED by NASA

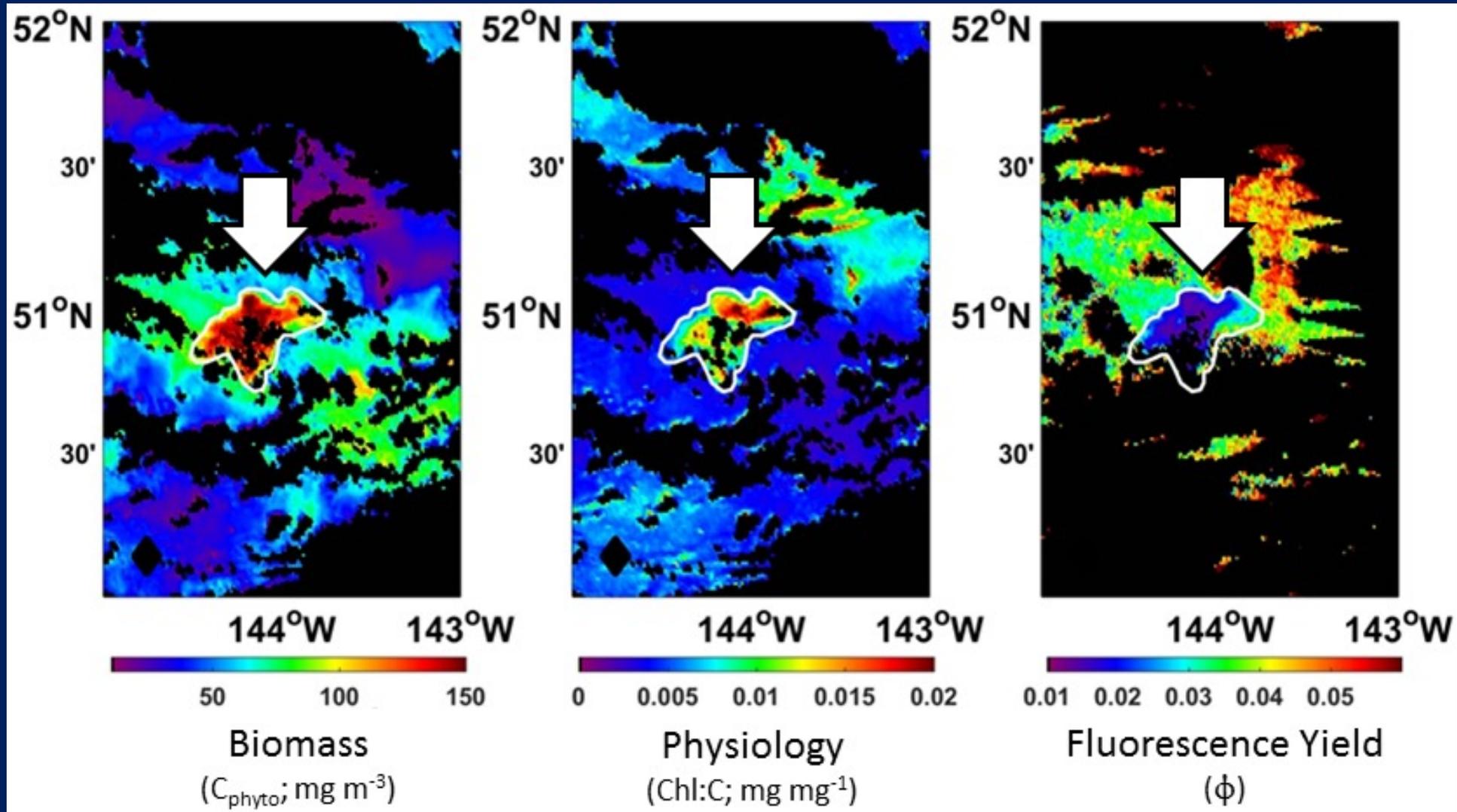
Woo hoo!

And now 7 years later... we have our paper in Science.

# Remote sensing estimates of dust deposition in ocean and land basins

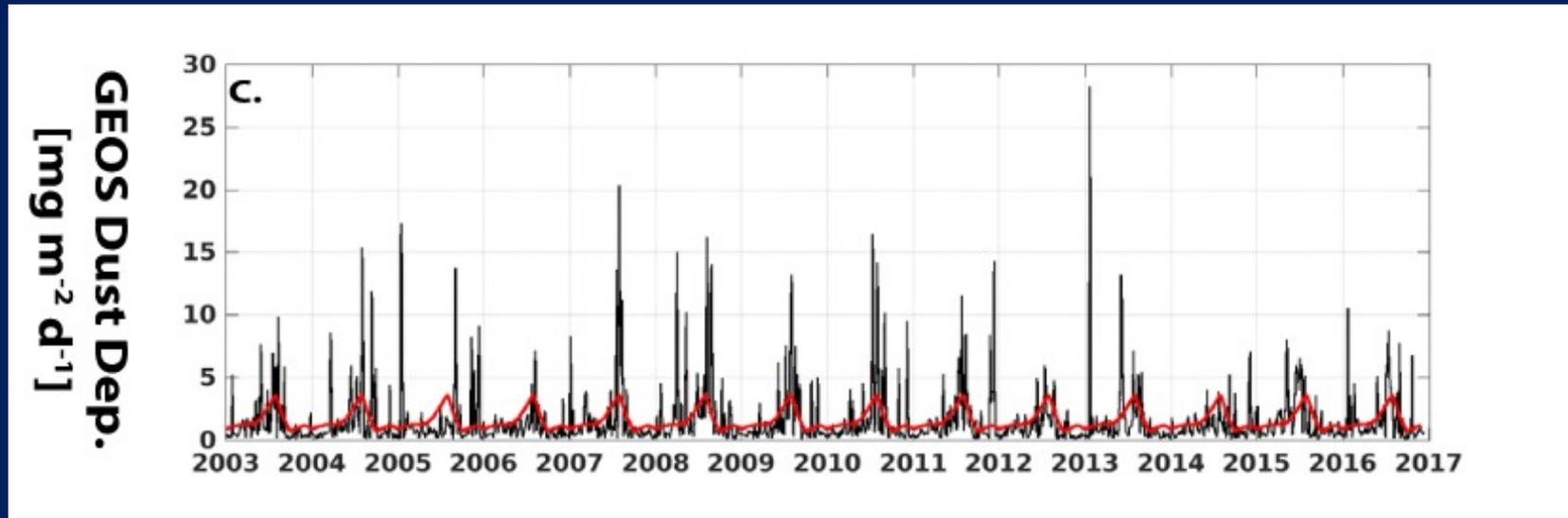


# Remote sensing signal from in situ iron fertilization experiments



The *atmospheric deposition* remote sensing methods were useful on time scales of months to seasons.

The *ocean response* took place on the order of days.

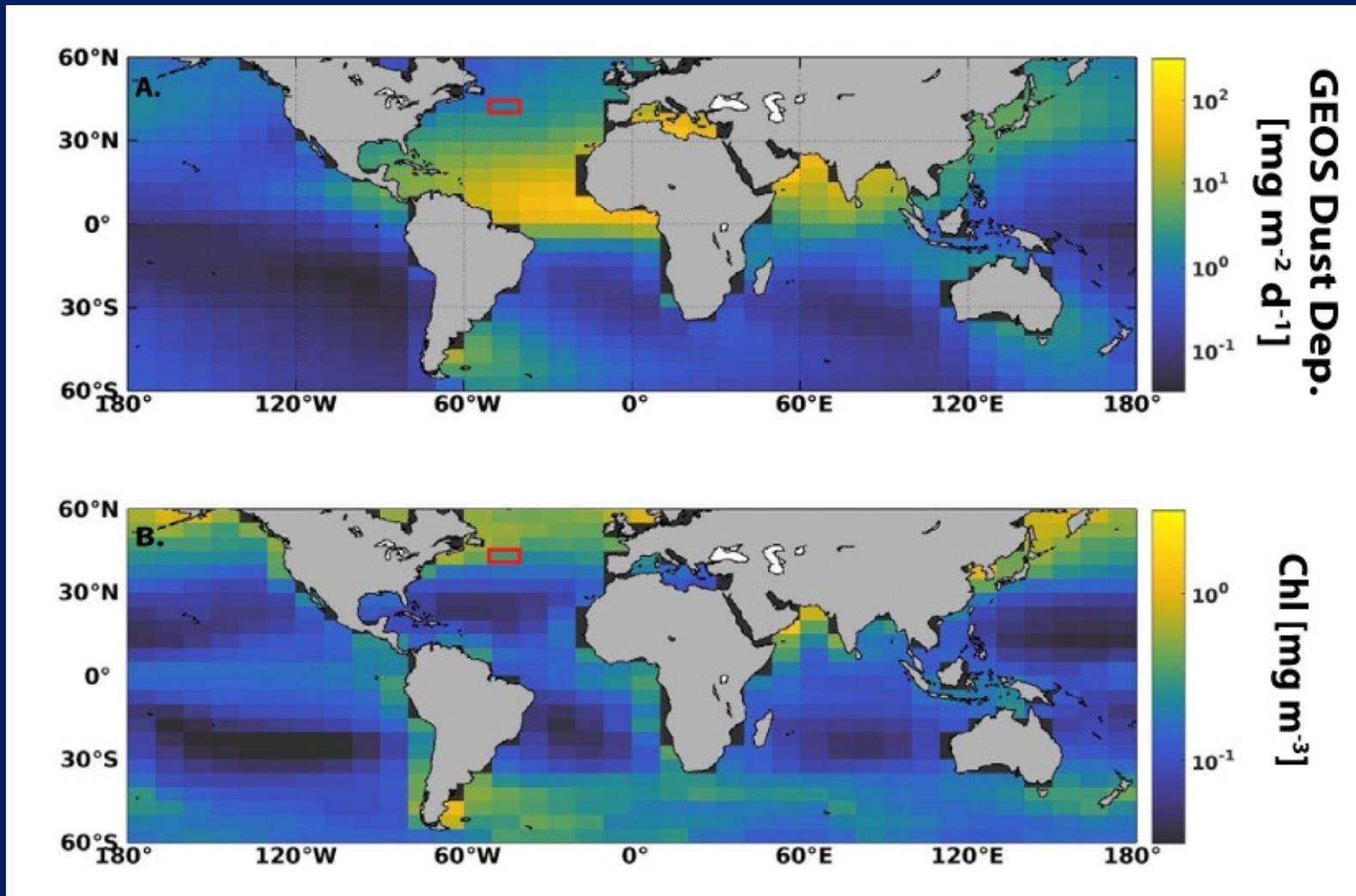


We addressed the issue by going to the Goddard Earth Observing System (GEOS) model to quantify dust deposition over 5° latitude by 10° longitude in 4-day tetrads.

GEOS aerosol loading has a long history of comparison using satellite products.

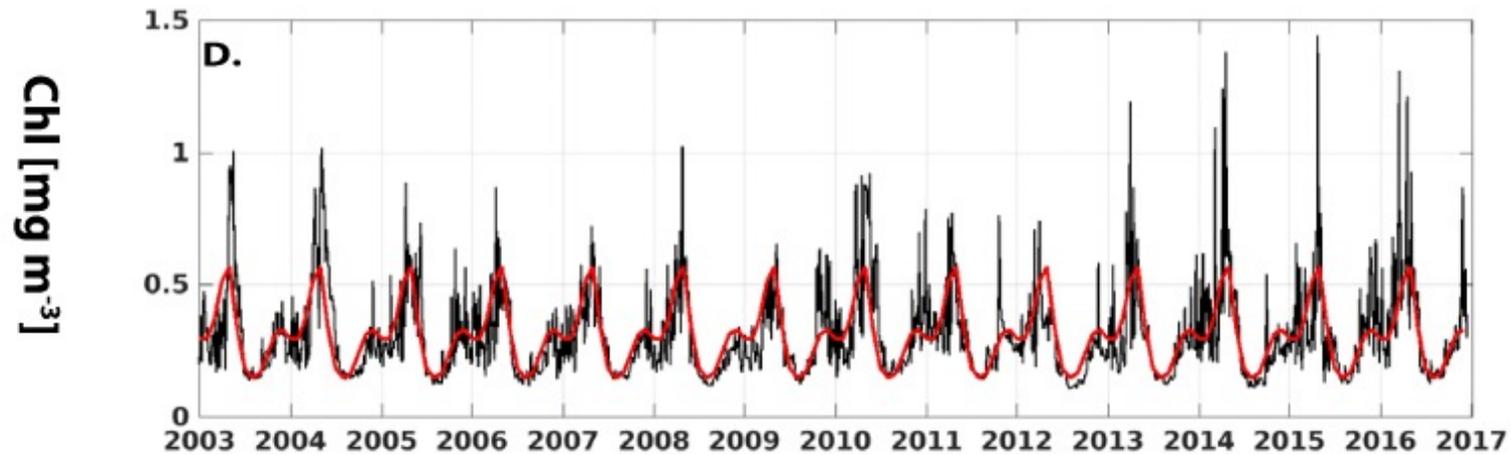
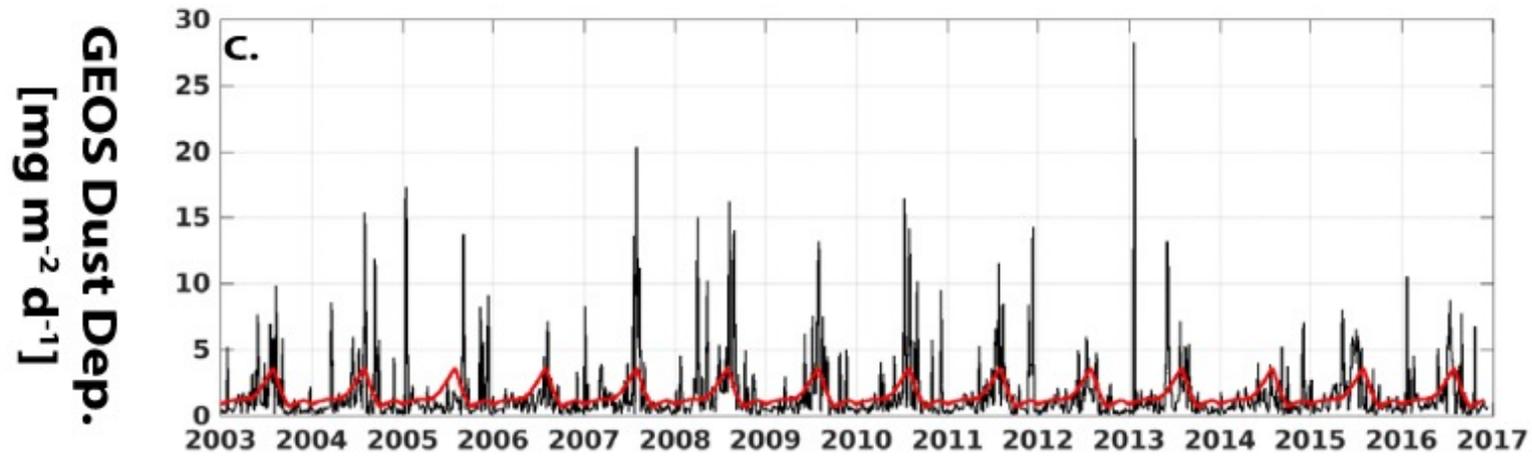
GEOS systematically underestimates *magnitudes* of deposition, but captures *events*

There is no spatial correlation between deposition and chlorophyll



Westberry et al., 2023

# Solution: Attack the problem temporally.



What is the response of the ocean to dust deposition events?

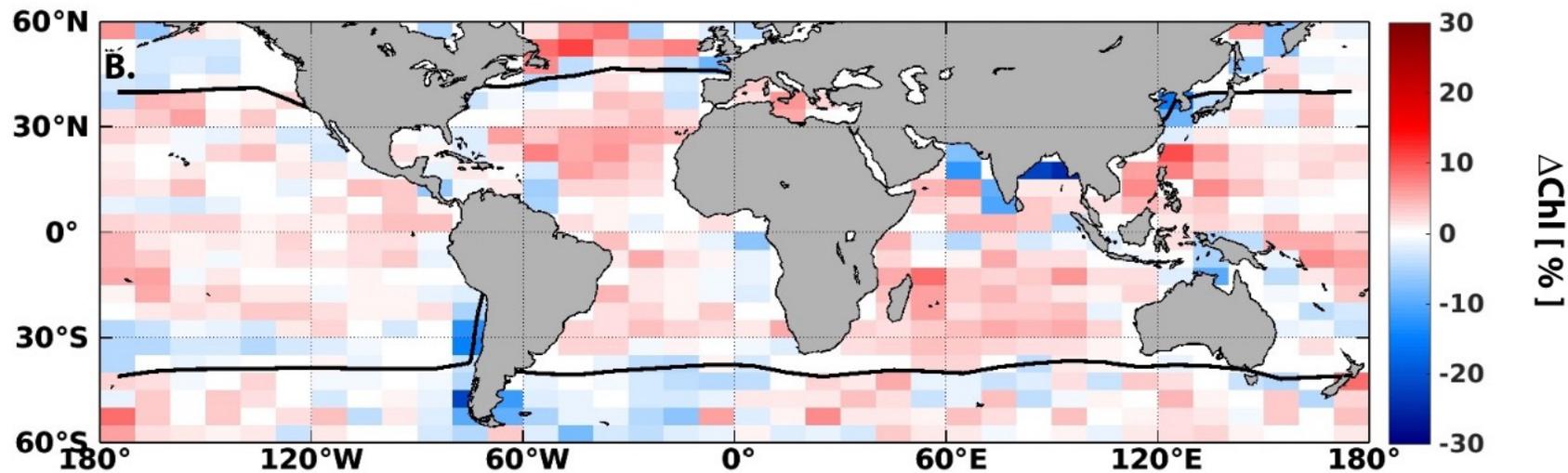
Response =

$$\text{OP}(t_{\text{event}} + 4 \text{ days}) - \text{OP}(t_{\text{event}} - 4 \text{ days})$$

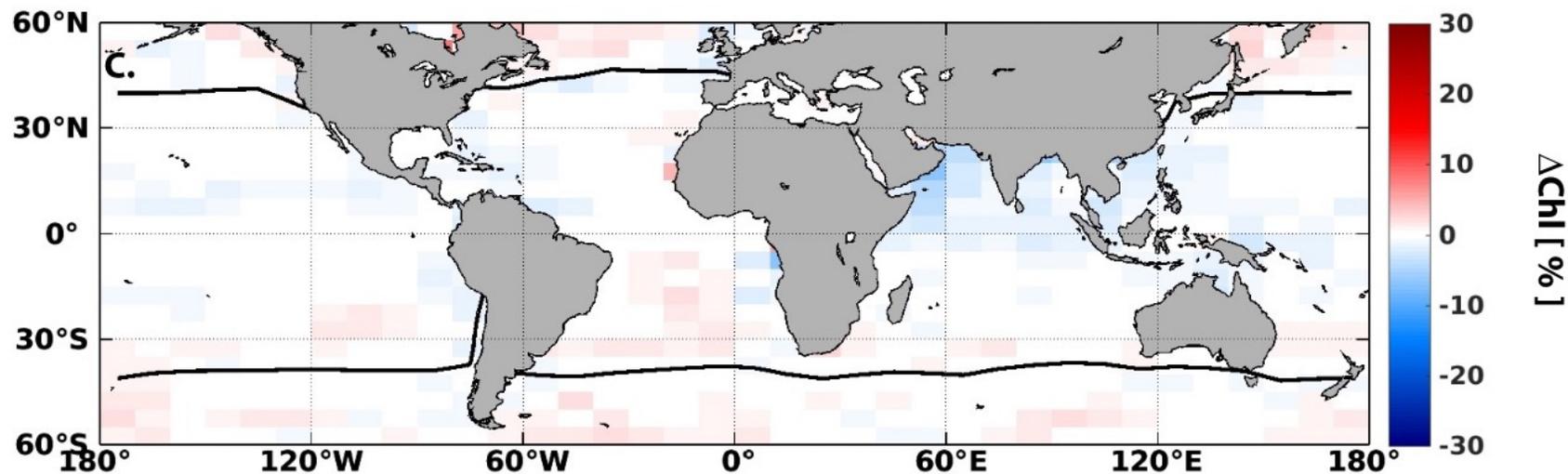
The *atmospheric* deposition of dust was most easily quantified in the *Atlantic*

The *iron limited* regions of the *ocean* ecosystems were not in the Atlantic

# Chlorophyll response from Aqua

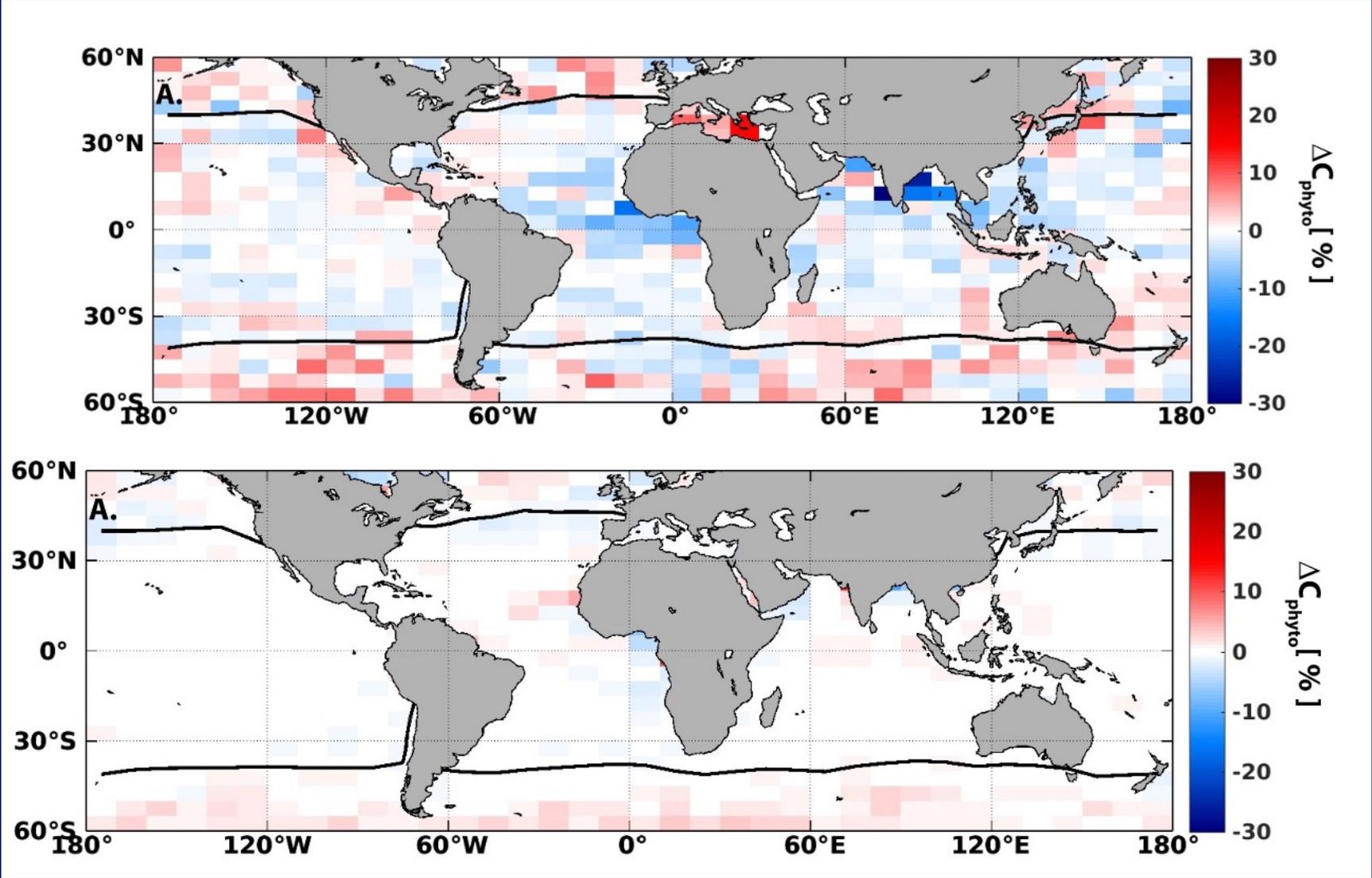


Top 10% of events

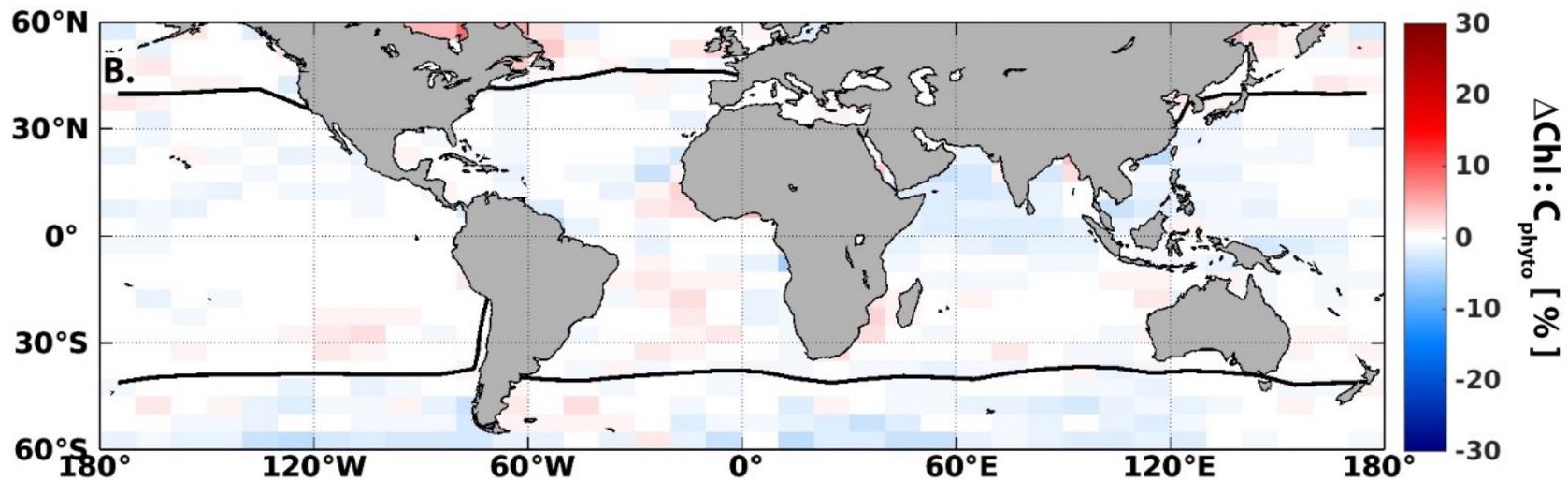
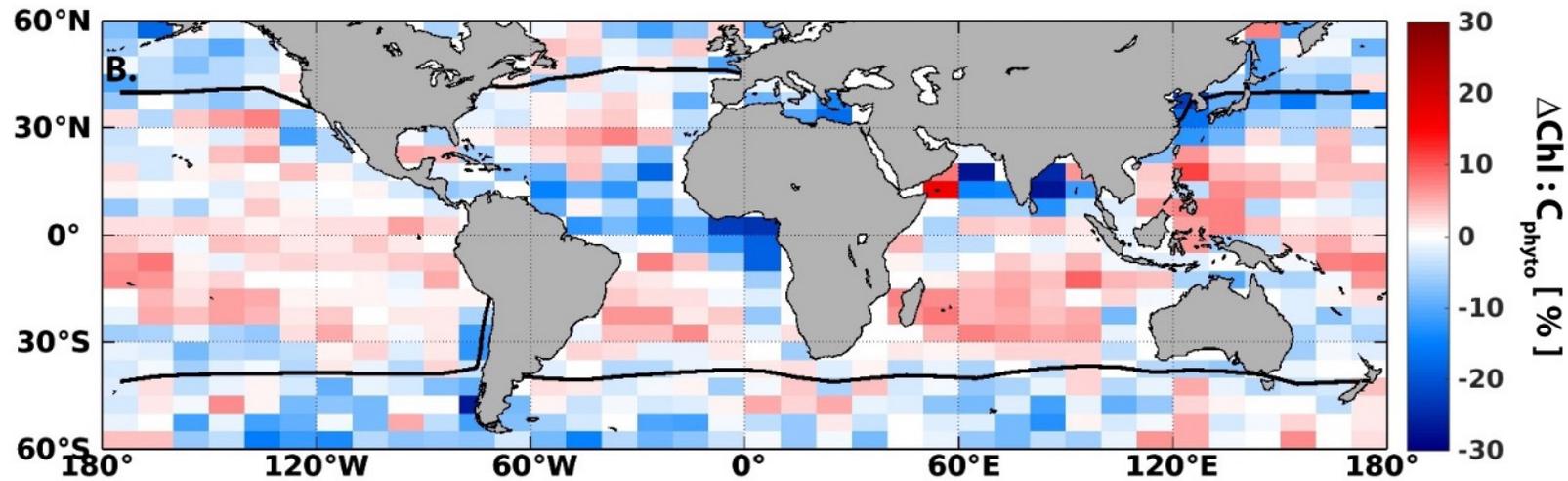


10% Randomly sampled

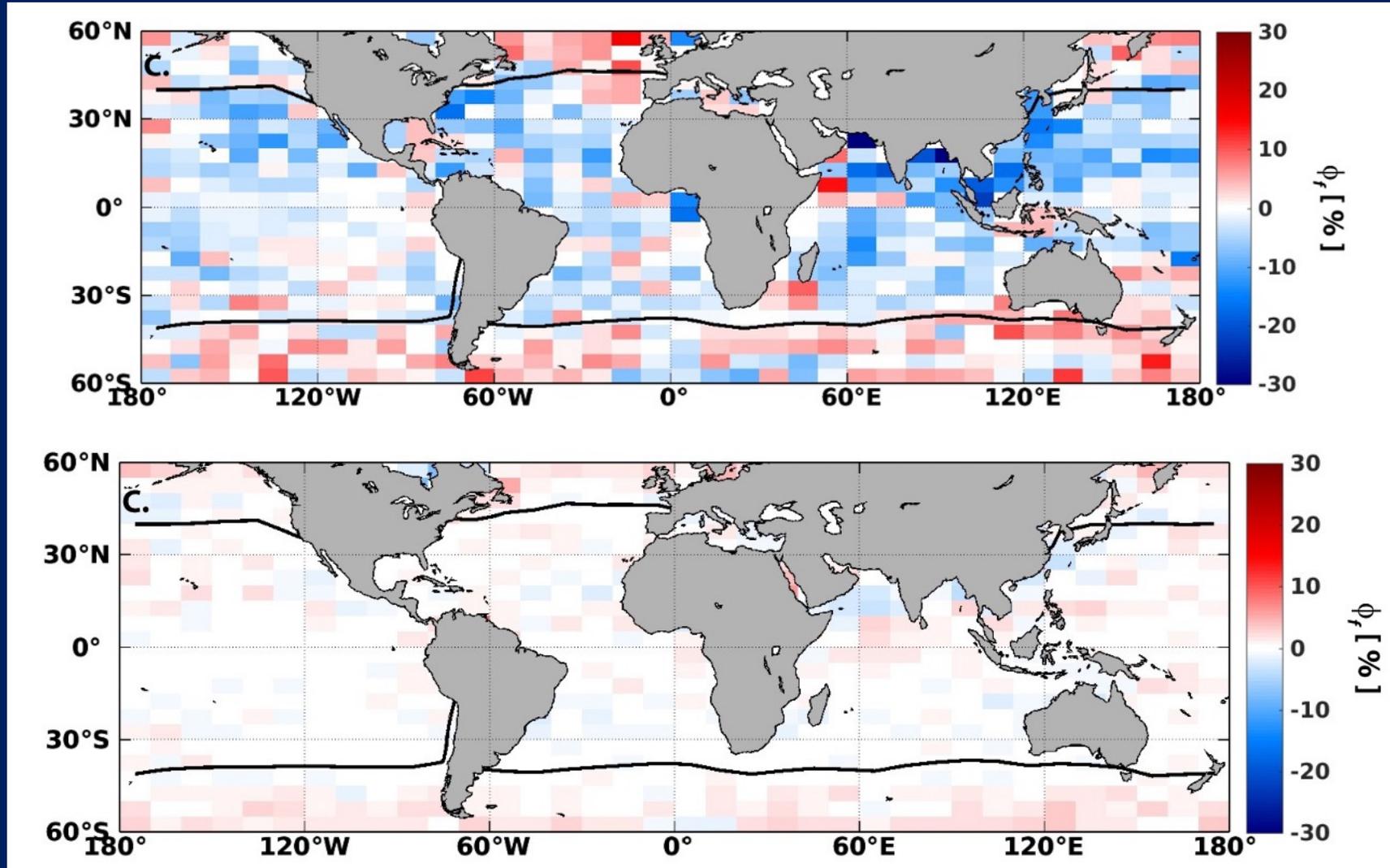
# Phytoplankton Carbon Biomass response from Aqua



# Chlorophyll to carbon ratio response from Aqua



# Chlorophyll fluorescence quantum yield ( $\phi_f$ ) response from Aqua



# Take home messages

Nourishment, not iron. Dust holds other nutrients like phosphorous.

Global, not just HNLC regions.

Dust events relative to background conditions. May be very modest amounts of dust, absolute

Response may be increased biomass or may be physiological changes

Atmospheric nutrients are not extraordinary, but part of the ocean system, which could change in a changing climate

7 years to get to this point. Many questions unanswered, especially concerning sources and chemical transformations of the dust.